Integrated Optics in Films of Organic and Polymeric Materials

Project Number: 97-07

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Purpose

The purposes of performing this work are, 1) to study thin film technology of organic and polymeric materials for improving applicability to optical circuitry and devices and 2) to assess the contribution of convection on film quality in unit and microgravity environments.

Background

Materials processing of interest are solution-based and by physical vapor transport, both having proven gravitational acceleration dependence. Polydiacetylenes (PDA) and phthalocyanines are excellent nonlinear optical (NLO) materials with the promise of significantly improved NLO properties through order and film quality enhancements possible through microgravity processing.

Approach

To focus research on integrated optical circuits and optoelectronic devices based on thin film organic and polymeric materials and processes under development in the Space Sciences Laboratory at MSFC. The processes of interest are solution-based and physical vapor transport of organic solids. Modification of organic materials is an important aspect of achieving more highly ordered structures in conjunction with microgravity processing. Parallel activities characterize materials for particular NLO properties and seek appropriate device designs consistent with selected applications.

Accomplishments

- Utilized optical bistability observed in phthalocyanine films from the last report to demonstrate an AND logic gate. Logic gates are the main building blocks of integrated circuits for optical computers, optical communication, etc.

- Constructed a permanent hologram using the polydiacetylene photodeposition process. Creation of the hologram occurred by interference of a reference beam and an object beam from an ultraviolet laser. Constructive and destructive interference of the beams led to a diffraction pattern on the developing film comprised of PDA material. These holograms can be useful for constructing high density storage media for a number of vital applications such as pattern recognition, holographic optical elements, holographic interconnections for neural networks, etc.

- Successfully modified molecular structure of diacetylene (DAMNA) to improve molecular orientation of photodeposited polymer for inducing second-order nonlinearity.

Planned Future Work

- Continue studies to produce ordered polydiacetylene films for near-term devices.

- Continue development and characterization of logic gates using vapor deposited films of phthalocyanines.
- Construct holographic images at the focal plane of probe and pump writing beams in PDA films.

- Study gravitational effects, expected to be significant.

Publications

- Published paper: "Buoyancy-Driven Heat Transfer During Application of a Thermal Gradient for the Study of Vapor Deposition at Low Pressure Using an Ideal Gas," *Journal of Crystal Growth*, 171, pp. 288–302, 1977.

- Published paper: "Effects of Convection During the Photodeposition of Polydiacetylene Thin Films," *Journal of Crystal Growth*, 173, pp. 172–181, 1997.

- Photonic Polymer Systems, Chapter: "Microgravity Processing and Photonic Application of Organic and Polymeric Materials," Publication: Marcel Dekker, In Press for March 1998.

- Submitted paper: *Journal of the Optical Society of America–B*, "Intensity-Dependent Changes in the Third-Order Nonlinearity of Polydiacetylene Using Z-Scan Technique," 1997.

- Submitted paper: Optics Communication, "Excited State and Reverse Saturable Absorption in Polydiacetylene Using Z-Scan," 1997.

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Unprocessed balance:	0.0

Status of Investigation

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Follow-on effort: second-year tasks which build on AND logic gate development in phthalocyanine films and high-density holographic storage in polydiacetylene films.